UNIVERSIDADE DE LISBOA
Faculdade de Medicina

Audio-perceptive analysis of the Parkinsonism associated dysarthria by different health professionals, patients, relatives and from general population.

Joana Margarida do Nascimento Fagundes Carvalho

Orientadores: Prof. Doutor Joaquim José Coutinho Ferreira
Profª. Doutora Isabel Guimarães

Dissertação especialmente elaborada para obtenção do grau de Mestre em Neurociências
2017

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RESUMO

A doença de Parkinson (DP) idiopática é uma doença neurodegenerativa que se manifesta com sintomas motores e não-motores, um deles, a disartria hipocinética, que se insere nos sintomas motores e é caracterizada por uma diminuída inteligibilidade do discurso. A inteligibilidade diz respeito à forma como o sinal de um falante pode ser ou não compreendido pelo seu interlocutor podendo variar consoante o interlocutor. **Objetivo principal**: compreender como a disartria é compreendida por diferentes grupos de ouvintes. O *primary outcome* foi definido como sendo o total de palavras corretamente compreendidas por cada participante de cada grupo. **Métodos**: foram recolhidas avaliações motoras e gravações áudio de Doentes de Parkinson com diferentes níveis de disartria. Posteriormente foi reunido um júri que incluiu terapeutas da fala, neurologistas, doentes de Parkinson, familiares de doentes de Parkinson e pessoas sem qualquer tipo de contacto com a doença. O júri realizou uma análise áudio-percetiva das gravações procedendo a registos ortográficos de palavras e frases e análise de articulação, velocidade de fala, volume e inteligibilidade do discurso. **Resultados:** houve diferenças na percentagem de palavras corretamente compreendidas entre os grupos, tendo apresentado os neurologistas maior percentagem de acerto. Os piores scores em relação a velocidade, intensidade, articulação e compreensão de discurso foram associados a disartria severa. A articulação e a inteligibilidade do discurso foram parâmetros que mostraram uma tendência para diminuir a par com a gravidade da disartria, para todos os grupos de jurados, tendo sido mostrada também uma forte correlação entre os dois. **Conclusões:** o nível de inteligibilidade do discurso varia consoante os ouvintes e os grupos profissionais que trabalham com disartria diariamente têm mais facilidade em compreender o discurso dos Doentes de Parkinson, mesmo que os familiares que passam mais tempo com os doentes. Os defeitos de articulação são mais facilmente percecionados por qualquer interlocutor comparando com a intensidade ou velocidade do discurso, e a articulação parece estar correlacionada com a inteligibilidade do discurso. A percepção de ambas é mais difícil à medida que o grau de severidade de disartria evolui, para qualquer grupo de interlocutores.

Palavras-Chave: inteligibilidade; disartria; análise áudio-perceptiva; Doença de Parkinson;

ABSTRACT

Parkinson's disease (PD) is a neurodegenerative disease with motor and nonmotor symptoms, one of them, hypokinetic dysarthria, is a motor symptom characterized by diminished speech intelligibility. Intelligibility concerns how a speaker's signal can be understood by his / her interlocutor and may be affected by factors intrinsic to the speaker but also by others associated with the listener. Improving speech intelligibility in PD is a therapeutic need.

Main goal: To understand how dysarthric speech is understood by different groups of listeners. The primary outcome was defined as the total number of words correctly understood by each participant of each group

Methods: Motor assessments and audio recordings of PD patients with different levels of dysarthria were collected. Subsequently, a panel was formed of speech therapists, neurologists, PD patients, relatives of PD patients and individuals without any contact with the disease. The panel conducted an audio-perceptual analysis of the recordings by orthographically transcribing words and sentences and performing articulation, speech velocity, volume and speech intelligibility analyses.

Results: There were differences in the percentage of words correctly understood between groups. Neurologists obtained the highest percentage. The worst results in terms of velocity, intensity, articulation and discourse comprehensibility were associated with severe dysarthria. The articulation and the discourse comprehensibility were parameters that showed a tendency to decrease with the severity of dysarthria, for all panel groups, and a strong correlation was also shown between the two.

Conclusions: The level of speech intelligibility varies according to the listeners. The professional groups working with dysarthria on a daily basis are the most likely to understand the discourse of PD patients, even when compared with the family members who spend the most time with the patients. Articulation defects are more easily perceived by all interlocutors compared to the intensity or speed of discourse, and articulation seems to be correlated with speech intelligibility. The perception of both is more difficult as the degree of severity of dysarthria evolves, for all groups of interlocutors.

Key Words: Intelligibility; dysarthria; audio-perceptive analysis; Parkinson's disease.

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ABBREVIATIONS LIST

International Parkinson and Movement Disorder Society (MDS)

Parkinson's Disease (PD)

Substantia nigra pars compacta (SNpc)

Monoamine oxidase B (MAO-B)

Upper airway obstruction (UAO)

Speech and Language Therapist (SLT)

Frenchay Dysarthria Assessment – 2nd edition (FDA-2)

Clinical Global Impression (CGI)

Montreal Cognitive Assessment (MoCA)

INTRODUCTION

Parkinson's Disease

The International Parkinson and Movement Disorder Society (MDS) defines Parkinson's disease (PD) as a neurodegenerative movement disorder, with predominant lesions in the basal ganglia, mainly in the substantia nigra, with a deficit of dopamine.[1,2] PD was first described by Dr. James Parkinson in 1817 and is generally considered a progressive neurodegenerative disease with motor, nonmotor, and behavioural symptoms being among the most prevalent neurodegenerative conditions.[3,4]

The worldwide prevalence of PD varies widely.[4] In Portugal, a 1994 study identified a prevalence of 130/100.000[5] and currently the estimated total number of cases of PD for the Portuguese population is 180/100 000 inhabitants.[6]

The cardinal motor symptoms of the disease are: bradykinesia, rigidity, rest tremor, and postural instability.[7] They are linked to the degeneration of dopaminergic neurons in the substantia nigra pars compacta (SNpc).[1,8] The non-motor symptoms include mood changes, cognitive changes, orthostatic hypotension, constipation and early satiety, hyperhidrosis, seborrhea, urinary urgency and incontinence, sexual dysfunction, loss of sense of smell, sleep disorders, insomnia and excessive daytime sleepiness (rapid eye movement behavioural disorder or active dreaming, dream enactment, involuntary movements and vocalizations during sleep, restless leg syndrome/periodic limb movement disorder; fatigue), and sensory problems (pain, tightness, tingling, burning).[7] These are related to the degeneration of other neuronal groups (e.g., serotoninergic neurons of the raphe nucleus, noradrenergic neurons of the locus ceruleus or cholinergic neurons of the nucleus basalis of Meynert).[1,8]

Pathophysiologically, PD is classified as a synucleinopathy.[9,10] α-synuclein is an abundant neuronal protein that is highly enriched in presynaptic nerve terminals.[11] Accumulation of misfolded oligomers and larger aggregates of α-synuclein define multiple neurodegenerative diseases including PD, but the mechanisms by which α-synuclein acts in neurodegeneration remains mostly unknown.[9]

The gradual loss of neurons results in a slow progression of symptoms and signs.[12] Nevertheless, PD is considered as highly heterogeneous in the way that the clinical signs manifest and the rate of progression of the disease.[13]

There is no specific test or method for PD diagnosis and this presents a challenge because early symptoms can mimic those typical of normal aging or of other neurologic

diseases.[14,15] Therefore, diagnosis is based on anamnesis, imaging tests, the response to medications and the clinical criteria are based on the relative sensitivity and specificity of clinical signs.[16] Currently, a variety of imaging techniques such as magnetic resonance imaging, diffusion tensor imaging, positron emission tomography, single-photon emission computed tomography and transcranial sonography may be used in the assessment of various parkinsonian syndromes.[17] For the clinical diagnosis of PD, the MDS reviewed the diagnostic criteria in 2015 and currently they use a two-step process: first, parkinsonism is defined (bradykinesia in combination with either rest tremor, rigidity, or both) and the criteria then define whether this parkinsonism is attributable to PD.[18] Before 2015 the UK Parkinson's Disease Society Brain Bank Clinical Diagnostic Criteria were widely used.[19]

Drug therapies have tended to focus on replacing dopamine – the major-medical approach to treating PD - or addressing specific symptoms associated with the disease.[2,8] Levodopa is still today the reference among anti-Parkinson's therapies.[20] Classifications of anti-PD medications include anticholinergics, dopamine agonists, amantadine, monoamine oxidase B (MAO-B) inhibitors, levodopa-carbidopa, and Catechol-o-methyl transferase inhibitors.[21]

Hypokinetic Dysarthria

Speech disorders were first mentioned in the description of PD by James Parkinson. He stated that "speech was slow, jerky and short of phrase… jolted out as it were, like an inexperienced rider on horseback, when the animal is trotting".[22] These features are attributed to hypokinetic dysarthria.

Dysarthria refers to a group of neurologic motor speech disorders, resulting from central and/or peripheral nervous system abnormalities and hypokinetic dysarthria is the typical speech disorder that presents in PD patients.[23–25]

Dysarthria classification is based on perceptual characteristics of speech and corroborated by the underlying neuropathology[26], but in general they are characterised by slow, weak, imprecise or uncoordinated movements of the muscles responsible for speech .[27] According to some authors, cranial motor deficits in the form of a hypokinetic dysarthria (and dysphagia) are reported in 90% of PD patients and there are studies that show an association of these with significant reductions in quality of life, social interactions and mental well-being.[23,25,28,29]

Hypokinetic dysarthria in PD typically shows reduced vocal loudness, flattened loudness and pitch inflections, poor voice quality, variable and frequently increased speech rate, inappropriate silences and breathiness.[30–32] The combination of rigidity and bradykinesia have repercussions in respiratory, musculoskeletal and stomatognathic systems.[33] Ultimately, respiration, phonation, articulation, resonance, and prosody are impaired in PD, these are the five subsystems responsible for speech and voice production.[34–36]

One shared characteristic in all dysarthrias is reduced speech intelligibility.[23,34] Reduced intelligibility can have a critical impact on communication abilities and may limit vocational, educational, and social participation which can greatly interfere with quality of life that can be greatly diminished.[34]

Voice and Speech Subsystems

Respiration

The respiratory cycle is composed of two phases[37]:

- Inspiration: active phenomenon that implies the contraction of the diaphragm and accessory breathing muscles (external intercostals, anterior serrate, sternocleidomastoid, and scalene muscles) leading to expansion of the thoracic cage, creating a negative pressure allowing the lungs to expand;
- Expiration: passive phenomenon where the relaxation of the inspiratory muscles allows the elastic recoil of the lungs and the thoracic cage, creating a positive pressure that expels the air out of the lungs.

Respiratory dysfunction which can strongly contribute to hypokinetic dysarthria, is a significant cause of morbidity and mortality in PD and is associated with increasing severity of PD.[38–41] It may be characterized by a hyporespiratory pattern that may result from rigidity - irregular activation of agonist/antagonist muscles or by akinesia of the intercostal muscles leading to a limited movement of the thoracic cage.[36,40] A study from 2010 divided respiratory dysfunction in PD into five subtypes: upper airway obstruction (UAO), restrictive disorders, complications of medication intake, complications of medication withdrawal, and aspiration pneumonia.[37] Studies show that UAO contributes to 70% of hypophonia in PD, attributed to rigidity and fatigability of the thyroarytenoid muscles during vocalization.[37,42]

Resonance

Hypernasality may result from abnormalities in the involved structures, and in this case is called velopharyngeal insufficiency (e.g., cleft palate) or from distorted neuromuscular control of the levator veli palatini muscle and velopharyngeal seal, called velopharyngeal incompetence (e.g., neurodegenerative diseases like PD).[43] In PD, because of the rigidity and bradykinesia, there are limitations of certain movements of the involved muscles, e.g., reduction of the opening of the mouth, that may interfere with patients resonance.[30,36] Hypernasality results from a velopharyngeal impairment and has been reported in PD.[26] It could be defined as "the presence of inappropriate air leakage through the nasal cavity during phonation".[26,44] Hypernasality in PD is not often perceived by the listener because of so many other dysarthria manifestations; studies have revealed that it was only perceptually detected in 10% to 30% of patients.[26,45]

Articulation

Imprecise vowel and consonant articulation is a common feature of dysarthria associated with PD which can be explained by a reduced amplitude of lips, tongue and jaw movements.[16,30,46-47] Studies of physiologic measures of lip and tongue suggest slower rates of force and difficulty maintaining a given contraction.[48] Vowels produced by individuals with dysarthria are characterized by articulatory undershoot (i.e., failure of the produced vowel to reach canonical formant frequencies – F1, F2), resulting in compressed or reduced working vowel space.[49] F1 and F2 frequencies are mainly defined by the tongue position with the simplified "rule" that the F1 frequency is inversely related to the height of the tongue whereas the F2 frequency is directly related to the frontal tongue position.[50] There is a restriction of articulatory gestures in PD and it is possible to note that on Triangular Vowel Space Area (Figure 1) assessed by plotting the F1 frequency as a function of F2 frequency for the vowels /a/, /i/, and /u/ in healthy controls and PD patients.[47] Studies also show imprecise consonant articulation, usually those that require the most constriction like /p/, /b/ but also /s/, /f/, as well as /R/.[51-52]

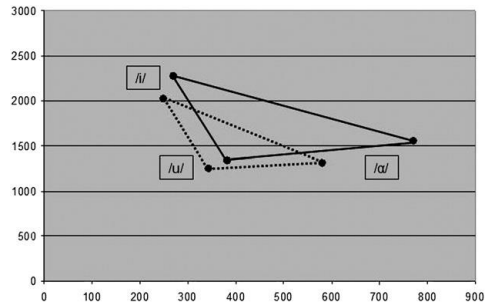


Figure 1: Triangular vowel space area of a healthy speaker and from a PD patient (dotted triangle)[47]

Speech rate is the amount of speech produced per time unit and can be measured by the amount of time an individual spends articulating and the amount of pause time.[53] Speech rate and rhythm are also compromised in PD which can be induced by complex dysfunction of planning, preparing and executing of motor speech sequences.[54] Studies have shown that complex motor abnormalities seen in PD such as festination, hesitation, tremor, apraxias, akinesia, and dysprosody are also reflected in speech articulation.[55-56] One of the most disabling axial symptoms in PD is festination, a tendency to speed up when performing repetitive movements and this was reported in gait, handwriting, and also in speech.[57]

Phonation

Resulting from rigidity and bradykinesia typical of PD, laryngeal, respiratory and thyroarytenoid muscle movements are limited; it is described as a reduced amplitude of vocal fold movements, irregular vocal fold vibrations or low variety of vibration that may lead to glottal incompetence.[30,36,55,58-59] Consequently, this leads to reduced voice volume (hypophonia), poor initiation of phonation and a harsh and breathy voice.[55,58-59] Another thing that may contribute to reduced voice volume is PD patients' deficit in the perception of loudness.[60]

Prosody

Prosody consists of "distinct subdimensions, namely speech rhythm and velocity, articulation rate and speech to pause ratio, and speech intensity and pitch variation (the relative highness or lowness of a tone as perceived by the ear).[30,56]

Alterations in speech rate and pause time, and speech intensity and pitch variation are well described as being associated to PD.[56] Inability to raise loudness of voice and vary pitch results in a low, monoloudness, monopitch and a hoarse voice.[55]

Intelligibility of speech

Intelligibility refers to how well a speaker's acoustic signal can be accurately recovered by a listener or it can be defined as the degree to which the acoustic realization of one's speech can be understood.[34,61] However, it can be measured based solely on the sound signal, the so-called signal-dependent intelligibility or it can be based on the immediate acoustic signal and on cues from any other verbal (e.g. syntax, semantics) or non-verbal sources (e.g., facial expression, gesture, broader contextual setting).[62-63] Signal-dependent intelligibility involves neither semantic/ syntactic context, nor visual aspects of communication like. gestures, but is purely determined by the performance of the speech production system.[61]

Typically, this signal-dependent intelligibility is measure by having listeners orthographically transcribe words or sentences that the speaker had read and a score is calculated dividing the number of words understood and the total number of words spoken.[63] In this process, it is important to note that there are two stakeholders: a speaker who produces an acoustic signal for the purposes of conveying linguistic content and a listener who receives the signal and interprets the linguistic content.[64] Thus, both production-related variables associated with the speaker and perception-related variables associated with the listener play key roles in intelligibility.[64] In a clinical context, the speech therapist listens to and rates the patient's utterances and this rating is consequently subjective as it is influenced by the listener's familiarity with the patient's voice, background and type of disorder and familiarity with the test material used.[61]

Intelligibility may influence the termination or continuation of treatment and in severe cases, the consideration of augmentative and alternative communication systems.[65] It is one of the main criteria used for the assessment of severity of speech disorders and improved intelligibility often constitutes a main goal of therapy.[66] This is why a comprehensive understanding of the factors that influence intelligibility and its measurement is critical.[65] Research has shown that intelligibility may be affected by many variables like:

- Message:
    - The speaker's task e.g., saying words vs. sentences.[64]
    - Message predictability.[67]
    - Message length.[65]
    - Linguistic information e.g., real words vs. not real words.[61]
    - Visual-facial information.[68]
- Environment/ Context:
    - The transmission system e.g., live voice vs. recorded voice.[64]
    - Contextual cues.[69]
- Listener:
    - Familiarity.[65]
    - Listener experience.[70]

Audio-perceptive analysis

Speech perception and comprehension often involves the need to recognize degraded or unclear speech sounds.[71] Speech comprehension comprises several hierarchically-organized processing stages – lower-level acoustic and phonetic features are identified and (potentially) categorized into larger units (phonemes or syllables) to recognize familiar words and then access syntactic and semantic properties.[71] The speed and accuracy of human speech comprehension when challenged by perceptual ambiguity is considered remarkable by Davis et al. as it seems to imply a neural hierarchy—temporal (left temporal cortex) and frontal regions (left frontal operculum; precentral gyrus; left anterior insula) with multiple processing pathways, activation of the superior temporal gyrus (STG) close to the primary auditory cortex—seen in functional neuroimaging data.[71–74]

Evidence suggests that there are four top-down processes that contribute to speech perception: (1) perceptual grouping of speech sounds into a single coherent stream, (2) segmentation of speech into meaningful lexical units, (3) perceptual learning mechanisms by which distorted and degraded speech is perceived and understood and (4) mechanisms for perceiving variable forms of speech in a categorical fashion.[75]

According to the Davis et al. these top-down processes are influences that act on auditory, echoic representations of incoming speech, and there are influences that arise from the interface between speech perception and speech production.[75]

A study from 2012 unequivocally demonstrated that clear speech can be processed even when ignored but degraded speech is processed depending on the listener's state of attentiveness.[76]

Aims and hypotheses

The main planned objective of this study was to understand how dysarthric speech is understood by different groups of listeners. In particular we sought to examine auditory sensitivity to dysarthria by different interlocutors who are part of PD patients' everyday life. The main hypothesis for this study was that different groups of listeners—speech and language therapists (SLTs), general population, relatives of PD patients, PD patients and neurologists,—would have different hit percentages in intelligibility tasks with words and sentences recorded from PD patients distinguished with different degrees of severity of dysarthria.

The secondary objectives planned for this study were:

1) To determine the inter-rater reliability within each group of listeners for the intelligibility tasks.

2) To determine if SLTs have a higher inter-rater reliability in their ratings of dysarthric speech when compared with naive listeners.

3) To determine whether listeners with greater interaction with PD (e.g., family members) have higher scores for the intelligibility tasks than the other groups.

4) To determine whether PD patients can more easily understand the dysarthric speech associated with PD than the other groups.

It was also hypothesized for this study that different groups of listeners would have different perception with regards to speech articulation, speech velocity, speech intensity or volume, and discourse comprehensibility, and this perception would differ according to dysarthria severity. The more severe the dysarthria, the worse the scores for each of these parameters.

Therefore, the primary outcome was defined as the total number of words correctly understood by each participant in each group. Secondary outcomes included the total

number of sentences correctly understood by each participant in each group and the mean scores of parameters assessed for each conversation including velocity, intensity, articulation and discourse comprehensibility, for each level of dysarthria severity.

METHODS

Design of the study

This is an observational cross-sectional study.

Participants

A panel was formed to listen to the corpus or recordings and to orthographically transcribe and register the words and sentences and also perform a perceptive analysis through the conversation samples. The panel was constituted of different interlocutors who normally have a relevant role in the daily life of a PD patient with different levels of familiarity, knowledge and experience with dysarthric speech.

The panel was composed of ten people from the general population who had no contact or experience with PD patients; 10 PD patients; 10 relatives; 10 neurologists and 10 SLTs. Participants were recruited from hospitals, centers of rehabilitation medicine and the senior neurological campus. Inclusion and exclusion criteria of the - panel are summarized in table 1. Demographical data from the different groups and patients' clinical problems are presented at tables 4 and 5.

	Inclusion criteria	Exclusion criteria
General population	· >=55 years; · Without any contact with PD patients, family, friends or acquaintances with the disease.	Diagnosed hearing loss or any auditory deficit perceived by the participant that prevented collaboration in the study; Diagnosed cognitive deficit or any cognitive deficit perceived by the participant that prevented collaboration in the study.
Parkinson's disease patients	· >=55 years; · >3 years since diagnosis; · Without relative cognitive impairment (MoCA).	
Parkinson's disease relatives	· >=55 years; · With daily contact with PD patient.	
Speech and language therapists	· working experience with adults; · Without daily experience in assessment and intervention with PD patients.	
Neurologists	· >5 years' working experience with PD patients;	

Table 1: Inclusion and exclusion criteria of the jury panel

Materials

Corpus – Selection and edition of audio-files recorded from PD patients

First audio files were collected—words, sentences and conversation—of PD patients, and the associated demographic information, global motor assessment, level of dysarthria and speech characterization were made by an experienced SLT. All this information was from the "Fralusopark - Dysarthria in Parkinson's Disease: Lusophony vs. Francophony Comparison"[77] project database and was provided by JJ Ferreira Lab, Instituto de Medicina Molecular. All patients are native Portuguese speakers, right-handed (Handedness Edinburgh test >80%)[78], with a medical diagnosis of Idiopathic PD according to the UK Parkinson's Disease Brain Bank Criteria[79] for the diagnosis of idiopathic PD.

From a database of sixty patients, ten PD patients who fulfilled the following criteria: male, >55 years old were included, three of these patients were diagnosed with mild dysarthria, three with moderate, three with severe dysarthria and one without dysarthria, the control subject. Only men were recruited in order to control the variable sex since there are differences between sexes in terms of speech characteristics which could influence the results. Speech diagnosis was performed by an SLT expertise in the assessment and treatment of acquired sensoriomotor speech disorders, using Frenchay Dysarthria Assessment – 2nd edition (FDA-2) protocol and a Clinical Global Impression (CGI) scale. The level of dysarthria severity level was analyzed by two other SLTs experienced in PD assessment and intervention. They performed an audio-perceptive analysis of the recordings also using CGI. All the SLTs agreed on the inclusion of the patients who were included in the present study. Demographical data and total scores from speech and global motor assessment are presented in the results section as patients' current clinical problems.

The audio-files selected from each patient include 5 single words and 5 phrases randomly chosen from a set of 12 words and phrases read by the patients. These words and phrases were also randomly chosen from a set of 109 words and 60 phrases available – illustrated in figure 2. They also included twenty seconds of a conversation cut from a two-minute conversation between the PD patient and the SLT in a way that the SLT does not interfere in the sample selected. A total of 50 different words, 50 different sentences and 10 conversation samples were finally selected. These words and sentences were part of the intelligibility tasks of FDA-2 that include a group of samples

with strong correlations in terms of distribution of frequency of phonemes, word length and type of syllabic structure involved. All patients were recorded in a quiet room with special speech recording equipment (Marantz PMD661 MKII recorder). Using Audacity software, the fifty words were put together in one single audio-file with silent intervals in between each word. In another single audio file the sentences were put together with a silent interval in between each. This time intervals were established so that the listener had time to write down the word.

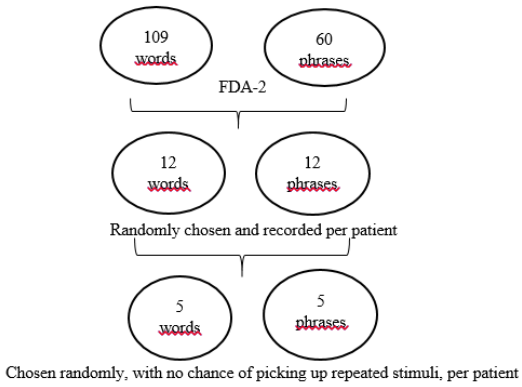


Figure 2: Process of selecting words and sentences for each patient

Information Sheet

An information sheet was prepared for panel members. This sheet collected information including: research project title, purpose, proceedings, possible benefits, predictable physical risks, voluntary form of participation and right to leave the study, the use of data, and contact details. The participants had access to this information sheet before agreeing to participate in the study. If, after reading all this information and taking all doubts into consideration, the participant agreed to proceed, an informed consent was presented in order to obtain his/her consent. ANNEXE I

The researcher was present during orthographic annotations in order to make sure that each file (word or sentence) was only reproduced once, to ensure the intelligibility of the participants' writing and to make sure that none of the parameters to be evaluated was forgotten.

Informed Consent

The informed consent sheet explained that the participant was part of a research project title, and informed on the purpose, proceedings, possible benefits, predictable physical risks, voluntary form of participation and right to leave the study, the use of data and contact details. To confirm acceptance, the participant signed the form as did the investigator. The original document remains with the investigator and a duplicate with the participant. ANNEXE II

Case Report Form (CRF)

A CRF was created to be completed by the investigator with demographic data of the panel, and blank spaces provided so that the panel members could transcribe the words (50 blank spaces) and the sentences (50 blank spaces). Ten tables were also included that consisted of four parameters each—speech velocity, intensity, articulation and speech comprehension—and 5-Likert type options per parameter (two options below the normal one, the normal option and two more above), to select according to the perceptual analysis of the conversation – ANNEXE III.

Proceedings

First the panel members were informed about dysarthria and intelligibility of speech concepts by reading the information sheet. The proceedings were described and if the participant wished to continue, they signed the informed consent. The audio files–words and sentences—were presented separately, only once, via headphones. Between each word there was a four second interval and between each sentence a seven second interval. Extra time for intervals was dictated by the transcription pace of the listeners or, other reasons: if a panel member asked, if the panel member paused to think about what had been heard before writing it down, if a panel member was tired; if for some reason a panel member asked. The investigator controlled the playing of audio-files and was prepared to pause if necessary. The panel members were instructed to write down what they heard in capital letters so that the investigator could understand what was written down.

Then, before the conversation audio/perceptive analysis of four parameters that the panel assessed—speech velocity, intensity, articulation and speech comprehension—were described in the CRF and examples were given for each one. The proceedings were described. Each table had the four parameter listed and each parameter had 5 options to characterize the conversation sample:

- Speech velocity: very slow (0), slow (1), normal/ adequate (2), fast (3), very fast (4)
- Intensity: very low (0), low (1), normal/ adequate (2), loud (3), very loud (4)
- Articulation: very bad (0), bad (1), normal/ adequate (2), good (3), very good (4)
- Understanding speech: very difficult (0), difficult (1), normal/ adequate (2), easy (3), very easy (4).

For statistical analysis purposes, each classification corresponded to a value reported between parentheses. The conversation was played once. If the panel member considered part of the conversation with one characteristic and another part differently, it was possible to select two or more options for each parameter.

Statistical Analysis

Characterization of PD patients' recordings was reported by describing the following variables: age (mean and standard deviation), years of education (mean and standard deviation), place of birth and living place since when, first symptoms and diagnosis data, total scores of FDA-2 (mean ± SD, max and min.) and MDS-UPDRS (mean ± SD, max and min.). The clinical problems and voice symptoms were also reported and percentage values presented.

Characterization of the participants from the panel was reported by calculating the mean and standard deviation for the quantitative variables and counts and percentages for categorical variables.

The total of words correctly understood in the intelligibility task by all participants was calculated and presented by hit percentages, and means and standard deviations per group. Whether the data followed a normal distribution for all groups was verified with a Shapiro Wilk test and homogeneity of the variances with a Levene's Test. For the comparison of results of correct orthographic transcription of words between the groupsa Kruskall-Wallis test was performed, and because the the homogeneity of the variance (Levene's test) was not verified, a non-parametric test was chosen. The test was adjusted for tied ranks and follow-up tests were conducted to evaluate pairwise differences among the 5 groups and the effect size for pairwise comparisons was

presented with statistically significant values. The same methodology was followed to study the correct orthographic transcription of sentences .

To examine inter-rater reliability—considered the measurement of the extent to which raters assign the same score to the same variable—within each group, the percent agreement was calculated, and which consisted of the number of agreement scores divided by the total number of scores.[80] For this it "correct" or "not correct" transcribed words or sentences were considered—a perfect match between all words and phonemes spoken and written by the panel.

The hit percentage of words and sentences was calculated per dysarthria severity level and per group.

The audio-perceptive analysis of speech samples was also examined and the four variables classified—articulation, speech velocity, intensity and ease of comprehension—mean values ± SD were calculated in relation to the level of dysarthria and also per group.

All descriptive and inferential results were obtained using SPSS ® Software, version 20.0 (SPSS, Inc., Chicago, IL) and p-values less than 0.05 were considered significant.

RESULTS

Characterization of PD patients recorded for material purposes

Subject Number	Age	Place of Birth	Living Place (since)	Years of Education	First Simptoms	Date of the Diagnosis	FDA-2 Scores	MDS-UPDRS Scores	Level of Dysarthria
1	59	Lisboa	Lisboa (always)	11	2010	2012	98	113	Normal
2	75	Alfeiria	Alfreiria (always)	2	1998	2000	90	193	Ligeiro
3	75	Torres Vedras	Torres Vedras (always)	5	2005	2005	85,5	217	Ligeiro
4	67	Lisboa	Lisboa (always)	10	2013	2014	97	148	Ligeiro
5	72	Elvas	Lisboa (1964)	4	2010	2012	89,5	151	Moderado
6	61	Proença a a Nova	Lisboa (1972)	4	2000	2002	85	169	Moderado
7	79	Vale de Cambra	Lisboa (1962)	18	2000	2000	81	181	Moderado
8	72	Viana do castelo	Lisboa (1968)	4	2005	2005	84,5	225	Grave
9	78	Torres Vedras	Torres Vedras (since ever)	16	ND	2000	57	182	Grave
10	84	Lisboa	Lisboa (>30 years)	14	ND	2002	72,5	197	Grave
Mean ± SD	72.2 ± 7.9			8.8 ± 5.8			84.0 ± 12.0	177.6 ± 33.8	

Table 2: Demographical data and total scores from speech and global motor assessment of PD patients that were recorded for material purposes. ND meaning "no data".

Subject Number	Motor Fluctuations (N%)	Dyskinesia (N%)	Postural Instability (N%)	Mild Cognitive Decline (N%)	Decreased voice volume (N%)	Slurred Voice (N%)
1	-	-	-	+	+	-
2	+	+	+	+	+	+
3	-	-	-	+	-	+
4	+	-	+	-	+	-
5	-	-	-	-	+	-
6	+	-	+	+	+	-
7	+	+	-	+	-	+
8	+	-	+	-	-	-
9	-	-	+	+	+	+
10	-	-	+	+	+	-
Total	5 (50%)	2 (20%)	6 (60%)	7 (70%)	7 (70%)	4 (40%)

Table 3: current clinical problems and voice symptoms of PD patients that were recorded for material purposes. + means it's present; - means it's not present

This sample was composed by ten men who had a mean age of 72.2 years ± 7.9 SD and 8.8 years of education ± 5.8 SD, all of them living in the Lisbon district for at least

30 years. Regarding symptoms, 8 individuals with first PD symptoms a maximum 2 years prior to diagnosis, 2 individuals with no data; 3 with 17 years since PD diagnosis, 2 individuals with 15 years of PD, 2 individuals with 12 years, and 2 with 5 years, 1 with 3 years of PD. The group had a mean FDA-2 score of 84.0 ± 12.0 SD, min 57 and max 98, with a mean MDS-UPDRS score of 177.6 ± 33.8 SD, min 113 and max 225. Data are presented in table 2.

Regarding current clinical problems and voice symptoms, 7 patients had mild cognitive decline (assessed with MoCA) and perceived decreased voice volume, 6 reported postural instability, 5 motor fluctuations, 4 slurred voice and 2 dyskinesia. Data are presented in table 3.

The level of dysarthria was defined by 3 SLTs experienced in PD disease. All of them perceptually classified dysarthria severity levels, 2 by listening to the recordings, and one face-to-face who also performed a complete assessment including FDA-2 and MDS-UPDRS. These patients were classified the same by the 3 SLTs regarding severity levels of dysarthria.

Characterization of participants of panel

	Age (years) (Mean ± SD)	Education (N (%))							Gender (N (%))	Musical Studies	Reading habits				Knowledge of PD
		0	1	2	3	4	5	6			1	2	3	4	
General Population (N=10)	62.60±6.17	0	5 (50%)	2 (20%)	3 (30%)	0	0	0	F: 6 (60%) M: 4 (40%)	Y: 1 (10%) N: 9 (90%)	0	8 (80%)	1 (10%)	1 (10%)	Y: 8 (80%) N: 2 (20%)
SLTs (N=10)	40.70±12.45	0	0	0	0	0	7 (70%)	3 (30%)	F: 9 (90%) M: 1 (10%)	Y: 4 (40%) N: 6 (60%)	0	7 (70%)	3 (30%)	0	Y: 10 (100%) N: 0
Neurologists (N=10)	43.90±7.42	0	0	0	0	0	6 (60%)	4 (40%)	F: 6 (60%) M: 4 (40%)	Y: 4 (40%) N: 6 (60%)	0	7 (70%)	3 (30%)	0	Y: 10 (100%) N: 0
Relatives (N=10)	65.00±6.04	0	2 (20%)	2 (20%)	0	2 (20%)	4 (40%)	0	F: 10 (100%) M: 0	Y: 1 (10%) N: 9 (90%)	0	7 (70%)	3 (30%)	0	Y: 10 (100%) N: 0
PD patients (N=12)	65.58±7.18	0	2 (16.7%)	1 (8.3%)	2 (16.7%)	1 (8.3%)	6 (50%)	0	F: 4 (33.3%) M: 8 (66.7%)	Y: 7 (58.3%) N: 5 (41.7%)	2	7 (70%)	3 (30%)	0	NA

Table 4: Demographical data for jury panel groups. Education level: 0 – Preschool; 1 - Elementary school; 2 - Middle School; 3 - High School; 4 - Further education, not higher; 5 - Higher education; 6 - Doctoral degree. Reading habits: 1 – without; 2 – daily; 3 – weekly; 4 - monthly

The PD patient group was constituted of 12 participants while the other groups comprised 10 participants each. The mean age was between 40 and 45 for SLTs and neurologists, and between 62 and 66 years for the other groups. Concerning education, SLTs and neurologists were the groups with the most years of education, 70% of SLTs and 60% of neurologists with higher education—bachelor's or master's degree—and 30% of SLTs and 40% of neurologists with a doctoral degree. Regarding sex, all groups except PD patients were constituted of a majority of women. None had undergone musical studies. In all groups there were a higher percentage of participants with daily reading habits and knowledge of PD. Data are presented in table 4.

Subject Number	Motor Fluctuations (N%)	Dyskinesia (N%)	Freezing (N%)	Hallucinations or delirium (N%)	Decreased voice volume (N%)	Slurred Voice (N%)	Hoarseness (N%)	MoCA scores
1	+	+	-	+	+	+	-	24
2	+	-	-	+	+	-	+	24
3	-	-	-	-	+	-	+	27
4	+	-	+	-	+	+	-	22
5	-	-	-	-	+	-	+	21
6	+	+	+	+	+	+	+	18
7	-	-	-	-	-	-	+	26
8	-	-	-	-	+	-	-	26
9	-	-	-	-	+	-	+	29
10	-	-	+	-	+	+	-	26
11	+	-	-	-	+	+	-	27
12	-	-	+	-	+	-	+	27
Total	5 (41.7%)	2 (16.7%)	4 (33.3%)	3 (25.0%)	11 (91.7%)	5 (41.7%)	7 (58.3%)	Mean 24.8 ± 3.1 SD

Table 5: Parkinson's disease patients group and their current clinical problems and voice symptoms. + means it's present; - means it's not present. MoCA scores ≤ 18 means

Regarding current clinical problems and voice symptoms of the PD patient group, 11 patients reported decreased voice volume, 7 reported hoarseness, 5 motor fluctuations and slurred voice, 4 freezing, 3 hallucinations or delirium and 2 dyskinesia. Data are presented in table 5.

In terms of frequency of contact with PD patients, relatives spent a mean 6.7 ± 0.3 days per week with PD patients and a mean of 14.3 ± 3.4 hours per day, while neurologists spent a mean 4.6 ± 0.3 days per week with PD patients and 4.4 ± 0.6 hours per day.

In terms of professional experience, SLTs reported a mean 17.9 ± 3.9 years experience working with adults, and neurologists a mean of 16.4 ± 2.8 years working with movement disorders, particularly with PD.

Primary outcome

Differences in the hit percentage of dysarthric speech (words) between groups

Table 6 presents the results established for the primary outcome—total number of words correctly understood by each participant of each group, the total hit percentage and the mean and standard deviation values for each group.

Participants	General Population N = 10	SLTs N = 10	Neurologists N = 10	Relatives N = 10	PD patients N = 12
1	27	33	37	31	28
2	29	30	36	28	22
3	33	34	33	20	26
4	31	31	39	37	22
5	28	31	35	31	34
6	33	37	35	28	20
7	30	33	35	30	22
8	31	33	33	33	31
9	27	35	33	33	28
10	32	37	36	32	35
11					35
12					34
Total (%)	**60.2%**	**66.8%**	**70.4%**	**60.6%**	**56.2%**
Mean ± SD	**30.1 ± 2.3**	**33.4 ± 2.4**	**35.2 ± 1.9**	**30.3 ± 4.5**	**28.1 ± 5.7**

Table 6: Total of words correctly understood in the intelligibility task by all participants', hit percentages, means and standard deviations by group. Each participant heard a total of 50 words.

Results show differences in the hit percentage of words correctly understood between groups. In ascending order PD patients < general population < relatives < SLTS < neurologists.

There was a normal distribution for all groups (Shapiro Wilk test: p-value > α) but the assumption of the homogeneity of the variances was not verified (Levene Test: p-value = 0.00 < α). A non-parametric Kruskal-Wallis test was conducted in order to evaluate overall differences among groups regarding median of total number of words correctly understood. The results of the analysis indicate that there are significant overall differences between the medians of the total words correctly annotated by the five groups, χ^2 (4, N = 52) = 19.0, p = 0.00 with a mean rank of 18.7 for the general population, 33.2 for SLTs, 41.7 for neurologists, 22.0 for relatives and 18.7 for PD patients. The effect size was not high, $\eta^2 = \chi^2/N-1$, $\eta^2=0.4$. Because the overall test is significant, pairwise comparisons among the 5 groups were completed and are presented in table 7.

	SLTs	**Neurologists**	**Relatives**	**PD patients**
General Population	χ^2 (1, N = 20) = 6.6, p = .01 η2=0.3	χ^2 (1, N = 20) = 12.9, p = .00 η2=0.7	χ^2 (1, N = 20) = 0.3, p = .60	χ^2 (1, N = 22) = 0.4, p = .55
SLTs		χ^2 (1, N = 20) = 2.6, p = .11	χ^2 (1, N = 20) = 3.5, p = .06	χ^2 (1, N = 22) = 3.962, p = .05
Neurologists			χ^2 (1, N = 20) = 8.7, p = .00 η2=0.5	χ^2 (1, N = 22) = 9.0, p = .00 η2=0.4
Relatives				χ^2 (1, N = 22) = .5, p = .49
PD patients				

Table 7: Kruskall-Wallis pairwaise comparisons for medians of words correctly understood

There are significant differences between the general population and SLTs, the general population and neurologists, neurologists and relatives, and neurologists and PD patients because, in these cases, p-value < α and the highest effect size was between neurologists and the general population, η2=0.678.

Secondary outcomes

Differences in the hit percentage of dysarthric speech (sentences) between groups

Table 8 presents the total number of sentences correctly understood by each participant of each group, the total hit percentage and the mean and standard deviations for each group.

Participants	General Population	SLTs	Neurologists	Relatives	PD patients
1	31	34	37	31	36
2	33	34	39	30	29
3	37	39	42	25	27
4	31	39	37	36	23
5	39	35	38	37	35
6	37	42	35	30	27
7	26	34	38	35	23
8	37	36	36	35	30
9	32	36	36	37	35
10	36	36	37	36	33
11					33
12					36
Total (%)	**67.8%**	**73.0 %**	**75.0%**	**66.4%**	**61.2%**
Mean ± SD	**33.9±4.0**	**36.5± 2.7**	**37.5±2.0**	**33.2±4.0**	**30.6±4.8**

Table 8: Total number of sentences correctly understood in the intelligibility task by all participants, hit percentages, means and standard deviations by group. Each participant heard a total of 50 words.

Results show differences in the hit percentage of words correctly understood between groups. In ascending order PD patients < relatives < general population < SLTs < neurologists.

There was a normal distribution for all groups (Shapiro Wilk test: p-value > α) but the assumption of the homogeneity of the variances was not verified (Levene Test: p-value = 0.00 < α). As for the words intelligibility task, a non-parametric Kruskal-Wallis test was conducted in order to evaluate overall differences among groups regarding the median of the total number of sentences correctly understood. The results of the analysis indicate that there are significant overall differences between the medians of the total sentences correctly annotated by the 5 groups, $\chi 2$ (4, N = 52) = 18.0, p = 0.00 with a mean rank of 26.0 for general population, 32.4 for SLTs, 39.9 for neurologists, 22.4 for relatives, and 14.3 for PD patients. The effect size was not high, $\eta 2= \chi 2/N-1$, $\eta 2=0.4$.

Because the overall test is significant, pairwise comparisons among the 5 groups were completed and are presented in table 9.

	SLTs	Neurologists	Relatives	PD patients
General Population	χ^2 (1, N = 20) = 1.4, p = .24	χ^2 (1, N = 20) = 4.0, p = .05	χ^2 (1, N = 20) = 0.6, p = .45	χ^2 (1, N = 22) = 3.0, p = .09
SLTs		χ^2 (1, N = 20) = 1.7, p = .19	χ^2 (1, N = 20) = 3.5, p = .06	χ^2 (1, N = 22) = 7.8, p = .01 η2=0.4
Neurologists			χ^2 (1, N = 20) = 7.612, p = .01 η2=0.4	χ^2 (1, N = 22) = 13.318, p = .00 η2=0.6
Relatives				χ^2 (1, N = 22) = 2.3, p = .13
PD patients				

Table 9: Kruskall-Wallis pairwaise comparisons of median number of sentences correctly understood

There are significant median differences between SLTs and PD patients, neurologists and relatives, and neurologists and PD patients because, in these cases, p-value ≤ α and the highest effect size was between neurologists and PD patients η2=0.6.

Comparing the hit percentages between words and sentences, there were higher values in all groups for correct orthographic transcription of sentences than words.

Inter-rater reliability calculated by means of percent agreement

	Group Interrater Reliability Words transcription	Group Interrater Reliability Sentences transcription
General Population	0.9	0.8
SLTs	0.9	0.9
Neurologists	0.9	0.9
Relatives	0.9	0.9
PD patients	0.9	0.8

Table 10: Interrater reliability for each group of judges

For the analyses of the interrater reliability, words and sentences were considered *correct* or *not correct.* The overall interrater reliability for each group was higher than 0.8, which demonstrates an almost perfect agreement between the panel members in the correct orthographic transcription of words—the majority of the panel members correctly transcribed the same words.

The same occurred for sentences, except for the PD patient group who demonstrated a strong agreement between the panel members of the correct orthographic transcription of sentences.

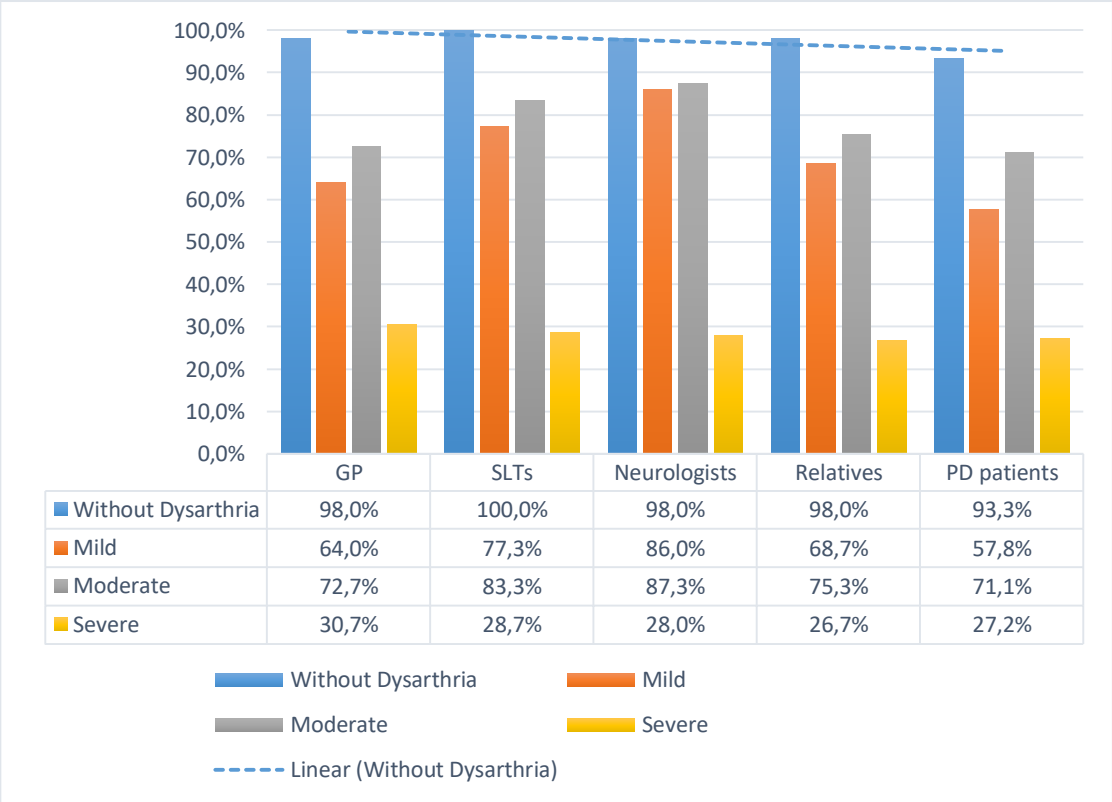
Data are presented in table 10.

Hit Percentage of words and sentences per level of dysarthria and per group

	Words				**Sentences**			
	Without Dysarthria	Mild Dysarthria	Moderate Dysarthria	Severe Dysarthria	Without Dysarthria	Mild Dysarthria	Moderate Dysarthria	Severe Dysarthria
N (%)	97.7%	67.3%	78.3%	30.4%	82.7%	77.1%	77.6%	45.8%

Table 11: percentage of words and sentences correctly transcribed per level of dysarthria.

In descending order of hit percentage of words correctly transcribed per level of dysarthria, without dysarthria > moderate dysarthria > mild dysarthria > severe dysarthria. The same happened with sentences correctly transcribed. These results are shown in table 11.

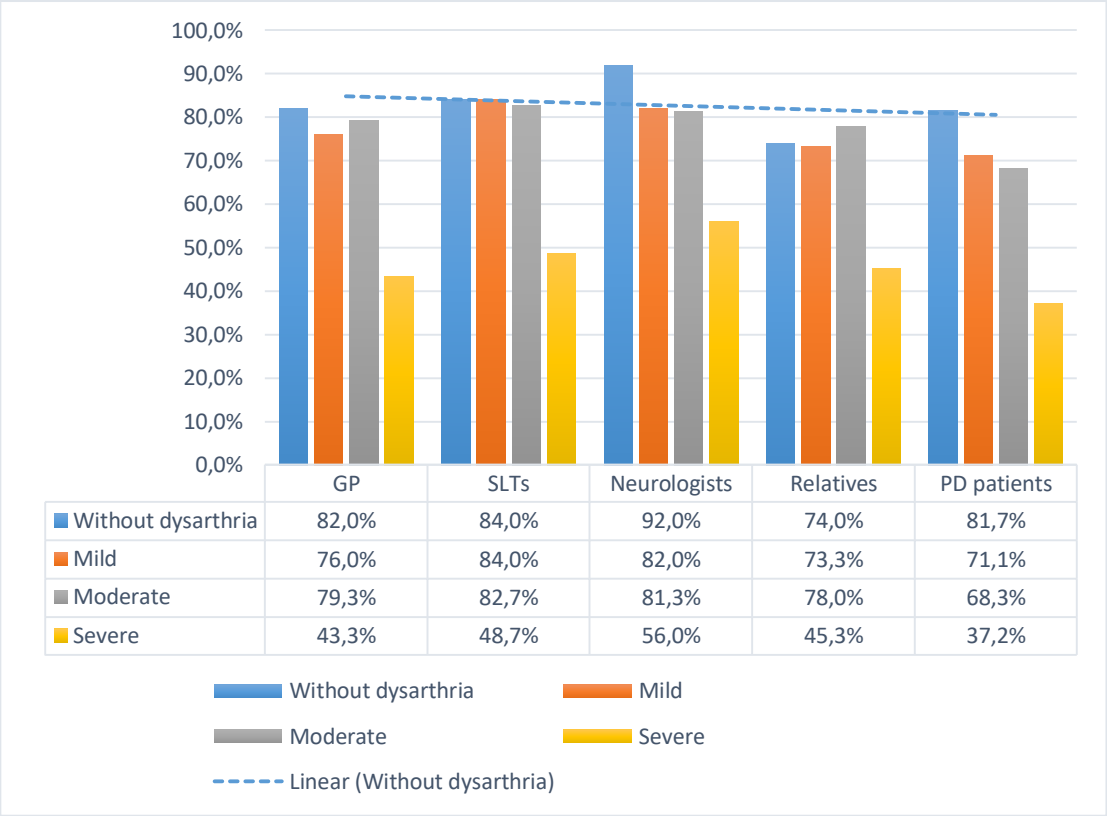


	GP	SLTs	Neurologists	Relatives	PD patients
Without Dysarthria	98,0%	100,0%	98,0%	98,0%	93,3%
Mild	64,0%	77,3%	86,0%	68,7%	57,8%
Moderate	72,7%	83,3%	87,3%	75,3%	71,1%
Severe	30,7%	28,7%	28,0%	26,7%	27,2%

Figure 3: percentage of words correctly transcribed per group and per level of dysarthria. Trend line represented in dashed lines.

Looking at the data presented in figure 3 it is possible to notice a group that stands out because of their lower values in the orthographic transcription of words, this was the PD patient group, who had the lowest values for all degrees of dysarthria severity except for severe dysarthria where the relatives group had the lowest hit percentage. The neurologist group had the highest values for mild and moderate dysarthria. The general population group presented the highest values for severe dysarthria, compared with other groups. SLTs presented a 100% correct transcription of words corresponding to the control participant, without dysarthria.

All groups had lower scores for mild dysarthria less compared with moderate dysarthria. For all groups, the hit percentage of correctly transcribed words was higher for people without dysarthria and lower for people with severe dysarthria.



	GP	SLTs	Neurologists	Relatives	PD patients
Without dysarthria	82,0%	84,0%	92,0%	74,0%	81,7%
Mild	76,0%	84,0%	82,0%	73,3%	71,1%
Moderate	79,3%	82,7%	81,3%	78,0%	68,3%
Severe	43,3%	48,7%	56,0%	45,3%	37,2%

Figure 4: percentage of sentences correctly transcribed per group and per level of dysarthria. Trend line represented in dashed lines.

Looking at the data presented in figure 4 it is possible to notice that the PD patient group had the lowest values for the orthographic transcription of sentences for all dysarthria severity levels, except for the control participant without dysarthria for which the relatives group had the lowest hit percentage, similarly to the intelligibility of words task. The SLT group had the highest values for mild and moderate dysarthria and had the same hit percentage of correct transcribed words for the control participant and mild dysarthria group. Neurologists presented the highest values for severe dysarthria, compared with the other groups and for the control participant, without dysarthria.

Something that was not expected and can be observed when comparing the correct hit percentages of general population and relatives groups between mild and moderate dysarthria, is that for mild dysarthria these groups obtained lower scores. For all groups, the hit percentage of correctly transcribed words was lower for people with severe dysarthria.

Audio-perceptive analysis of conversation

The audio-perceptive analysis of conversation included four parameters: velocity, intensity or volume, articulation of words, and discourse comprehensibility. The results analyzed per dysarthria severity level are shown in table 12.

Parameters	Dysarthria			
	Without Mean±SD	**Mild** Mean±SD	**Moderate** Mean±SD	**Severe** Mean±SD
Velocity	1.9±0.5	1.8±0.8	1.4±0.8	1.4±1.1
Intensity / Volume	2.2±0.4	2.1±0.7	2.1±0.7	1.1±1.0
Articulation of words	2.9±0,7	2.0±0,9	1.5±0.7	0.8±1.0
Discourse comprehensibility	2.9±0.8	2.4±0.9	2.1±0.8	0.9±1.0

Table 12: Parameters assessed for each conversation versus levels of dysarthria.

In terms of mean values, in descending order of parameters considered good or normal to parameters considered bad or very bad: without dysarthria > mild dysarthria > moderate dysarthria > severe dysarthria.

Mean values for those without dysarthric conversation classified speech with normal velocity, between normal and loud intensity or volume, between normal and very good articulation of words and between normal and very easy understanding of speech.

Mild dysarthria was classified with values between slow and fast velocity, low and loud intensity or volume, bad and good articulation of words, difficult and easy understanding of speech.

Moderate dysarthria received values between slow and normal velocity, low and loud intensity or volume, bad and normal/adequate articulation, difficult and ease of understanding.

Severe dysarthria was the only group of conversations receiving classifications of very slow velocity, very low intensity or volume, very bad articulation and very difficult to understand speech understanding.

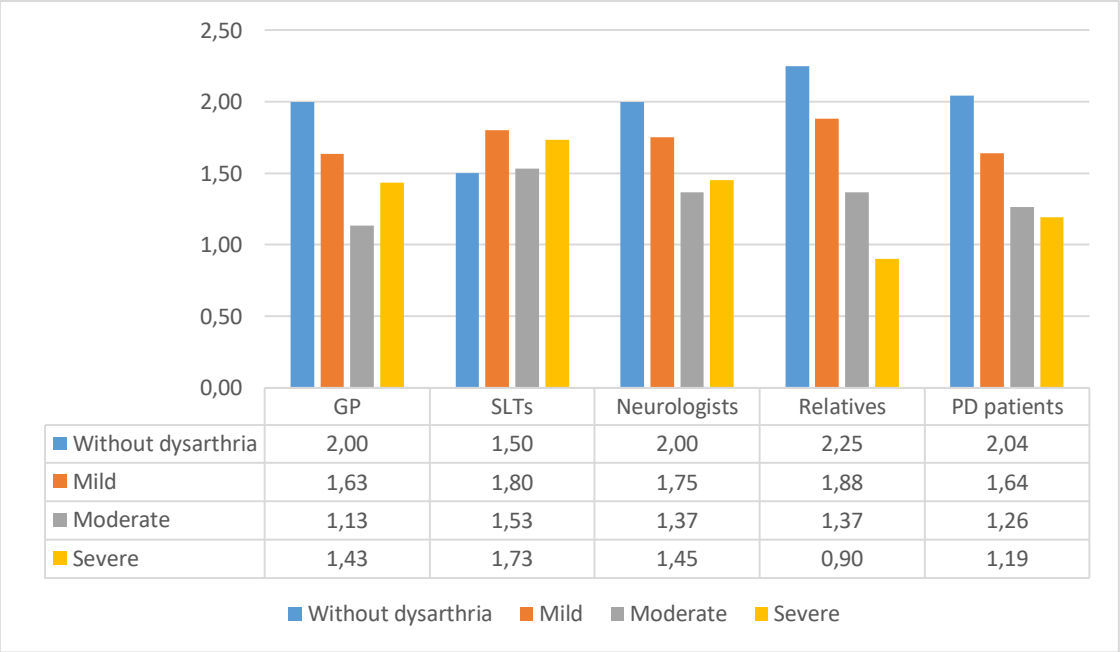


Figure 5: Audio-perceptive analysis of conversation parameter velocity per level of dysarthria and by all jury groups

In terms speech velocity of, SLTs were the most critical group of the control participant with a mean value of 1.5, which still corresponds to normal/adequate velocity as well as the perception of all the other panel groups. PD patients and general population groups were the most critical groups for mild dysarthria, but all groups presented mean values corresponding to normal/adequate velocity. Still, it is noteworthy that SLTs were more judgmental of the control participant than of the mild dysarthria group as far as this parameter was concerned. For moderate dysarthria, all groups presented mean values which corresponded to slow velocity, except for SLTs who had a mean score of 1.5 rounded to normal/adequate velocity of speech as in severe dysarthria, presenting a mean of 1.7. All the other panel groups' mean values for severe dysarthria corresponded with slow velocity, the relatives group was the most judgmental.

Data are presented in figure 5.

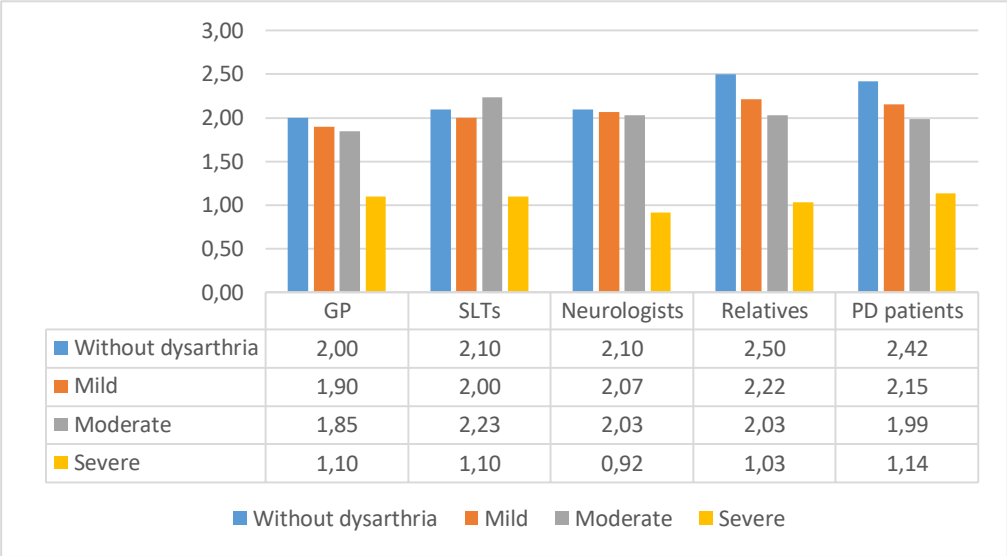


Figure 6: Audio-perceptive analysis of conversation parameter intensity per level of dysarthria and by all panel groups

For speech intensity , it is possible to look at the data in figure 6. Relatives were the only group who considered the control participant to have a high volume. All the other groups' mean values that corresponded to normal/adequate volume or intensity. For mild and also for moderate dysarthria, all panel groups had mean values that corresponded with normal/adequate intensity or volume with the general population being the most critical group, Relatives and SLTs were the least judgmental for mild and moderate dysarthria. For severe dysarthria, all panel groups presented mean values associated with low volume, with the neurologists the most critical.

In

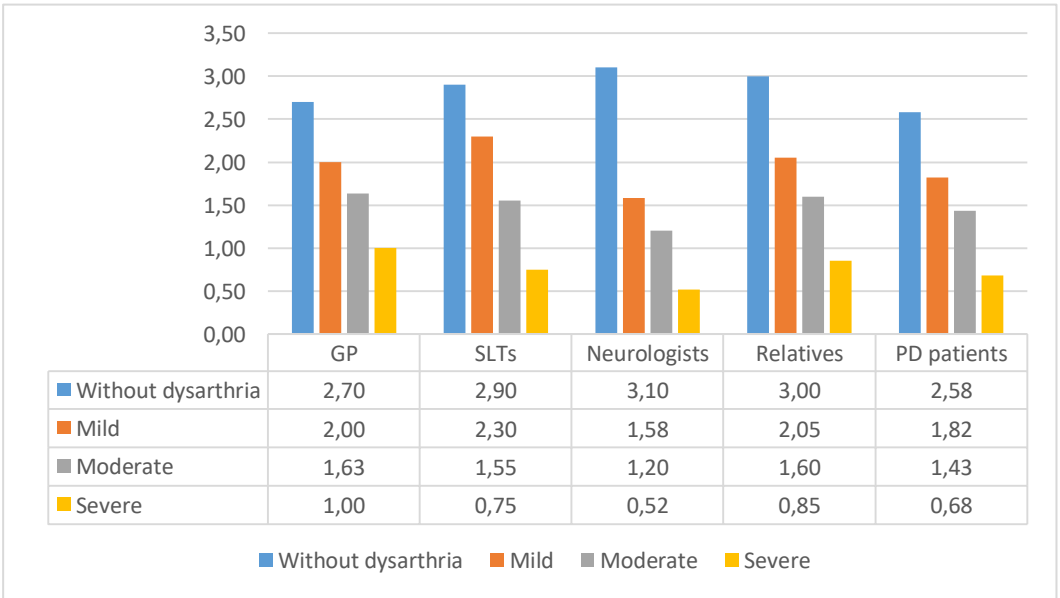
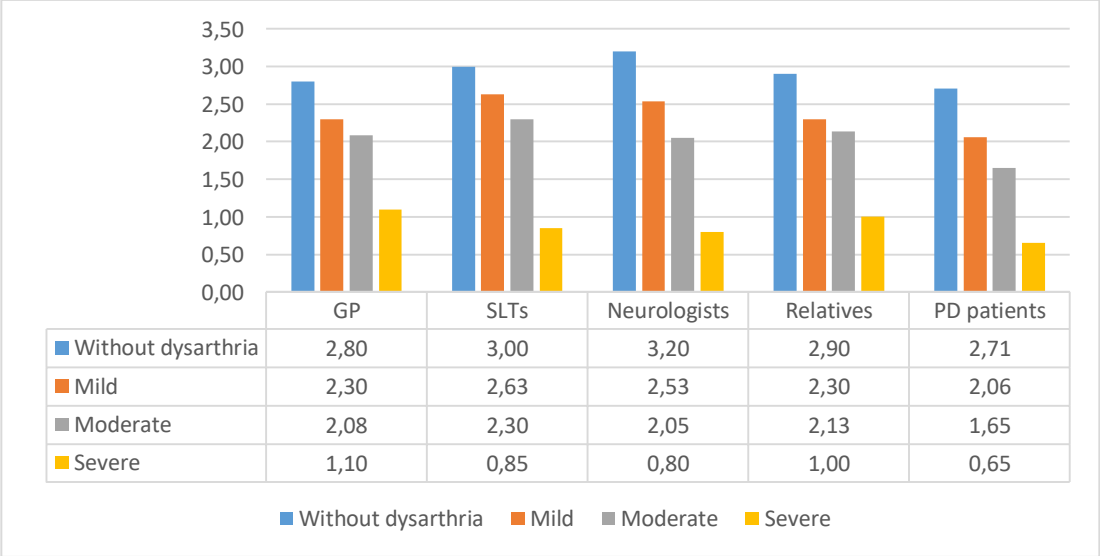


Figure 7: Audio-perceptive analysis of conversation parameter articulation per level of dysarthria and by all jury groups

terms of articulation, all -panel members presented mean values pointing to good articulation for control participants, neurologists had the highest with a mean of 3.1 and PD patients the lowest at 2.6. All groups had mean values corresponding to normal/adequate articulation for mild dysarthria, with the neurologists the most critical and SLTs the least critical. For moderate dysarthria, only two groups had mean values that did not correspond to normal/adequate articulation but were associated with bad articulation: neurologists and PD patients. For severe dysarthria, all jury groups had mean values associated with bad articulation, neurologists were the most critical group and the general population the least. Data are presented in figure 7.



	GP	SLTs	Neurologists	Relatives	PD patients
Without dysarthria	2,80	3,00	3,20	2,90	2,71
Mild	2,30	2,63	2,53	2,30	2,06
Moderate	2,08	2,30	2,05	2,13	1,65
Severe	1,10	0,85	0,80	1,00	0,65

Figure 8: Audio-perceptive analysis of conversation parameter discourse comprehensibility per level of dysarthria and by all panel groups

Relative to discourse comprehensibility, looking at the data presented in figure 8 it is possible to notice that only severe dysarthria had mean values from all panel groups that were associated with difficulty understanding speech, with PD patients the most critical group. The control participant had mean values from all groups that corresponded with discourse comprehensibility, and SLTs and neurologists both considered mild dysarthria as easy to understand. The other groups considered mild dysarthria as normal/adequate to understand and all groups also considered moderate dysarthria as being normal/adequate to understand.

Correlation between discourse comprehensibility and the other parameters

Discourse comprehensibility is a parameter that corresponds to the perception of speech intelligibility of each participant. Because this was the main focus of the study, the possibility of a correlation between this parameter and other parameters was investigated, namely velocity, intensity, and articulation. For this, Spearman's correlation was performed. Between discourse comprehensibility and articulation there was a strong uphill positive linear relationship that was statistically significant ((0.01 level [r_s = +0.7]). Between discourse comprehensibility and intensity there was a moderate uphill positive relationship that was statistically significant (0.01 level [r_s = +0.5]). Between discourse comprehensibility and velocity there was a weak uphill positive linear relationship that was a statistically significant (0.01 level [r_s = +0.3]).

DISCUSSION

The hypothesis of the current study main was verified and overall differences in the hit percentage of dysarthric speech between speakers with dysarthria, SLTs, naive listeners, relatives and neurologists, for words and sentences was assessed.

For orthographic transcription of words, neurologists hadthe highest hit percentage with 70.4% followed by SLTs with 66.8%, relatives with 60.6%, general population with 60.2%, and PD patients with56.2% . Pairwise comparisons showed significant differences between neurologists and all the other groups, except for SLTs, in the medians of the total words correctly annotated. There were also significant differences between SLTs and the general population. These results may be justified by the expertise of the clinicians, especially neurologists who have many years of direct experience working with PD. Despite years of experience working with adults and with different types of dysarthria, one of the main inclusion criteria for SLTs for this study was that they did not have direct experience working daily with PD. This may justify the difference between total scores of correctly transcribed words between the two groups of clinicians and point to a need for specialization and for evidence-based expertise. Some studies affirm that familiarizing the listener with the type of dysarthria has been found to produce intelligibility benefits[68,70,81] and Kreiman *at al*. defend that clinical training and experience might influence speech perception.[82] These studies support the results presented here, where clinicians who knew in advance the type of dysarthria associated with PD, and work with dysarthric patients in their clinical practice, presented greater percentages of correctness. In other studies, speech-language pathologists provided significantly higher intelligibility scores for the speakers with dysarthria.[83] The published literature also shows that clinicians who have experience with disordered speakers obtained higher transcription scores than inexperienced listeners,[84] which is in agreement with the findings in this study. As far as PD patients are concerned, their scores were the lowest. The published literature states that individuals with dysarthria may perceive their speech differently to those without dysarthria[67,85] and suggest that PD patients lack insight into their speech difficulties[63]. However, this is about PD patients listening to their own speech and not about PD patients' perceptions of dysarthric speech by other PD patients. A literature review about perception of speech by individuals with PD provided evidence that PD patients have a deficit in the perception of loudness and other speech dimensions such as pitch and

duration, deficits in perception of emotions in speech and prosody, as a result of general cognitive impairment.[60] All of this may justify the lower scores of PD patients in the tasks related to the intelligibility of words and sentences, taking also into account that MoCA scores of the group showed some cognitive impairment.

For orthographic transcription of sentences, neurologists were those who had the highest hit percentage with 75% followed by SLTs with 73%, the general population with 67.8%, relatives with, 66.4%, and PD patients with 61.2%. There are significant median differences between SLTs and PD patients, neurologists and relatives, and neurologists and PD patients. Again, the clinicians were the participants with the highest scores in the intelligibility tasks and, of note both clinicians groups had significant differences with the PD patient group, the group with the lowest scores. One result that was not expected was that the general population, a group with no contact with PD patients, had higher scores than relatives, a group of participants with daily contact with PD patients. Although the difference were not very large this fact goes against what was initially proposed, that listeners with greater interaction with PD would have higher scores in the intelligibility tasks. However, there are studies that show no difference when a listener was familiarized with disarthric speech,[65,67] and there are studies that have reported that prior familiarization with a specific speaker led to increased intelligibility scores[68,70] but the relatives group in this study were not familiar to the actual patients recorded in the audio-files, so familiarization cannot be considered with a specific speaker.

Familiarity with stimuli certainly produced higher scores than those not familiar.[65] In this study, none of the panel members was familiar with the stimuli so this was a controlled parameter in order to ensure more functional measures of intelligibility.

Comparing the hit percentages between words and sentences, there were higher values in intelligibility of sentences task for all groups except for the control one who had higher values in intelligibility of words task. The literature states that words are harder to understand in isolation than in a sentence because of absence of context.[65,66] Studies show that semantic predictability dramatically affects a listener's ability to understand dysarthric speech, with sentences that are more predictable resulting in higher intelligibility scores.[67] For the control participant, sentences seemed to be difficult to understand and this can be justified by the listeners' sensitivity to normal age-related changes in speech, perhaps especially changes related to voice or prosody as stated in a study from Sussman and Tjaden.[86] In this study, the scores of correct transcription of

sentences for severe dysarthria approached 50% for all groups, with exception of PD patients. This seems a high hit percentage taking into account the severity of dysarthria. In real life situations there are other cues that help in speech intelligibility like visual cues and so, these cues could help obtain 50% intelligibility, which seems unrealistic. However, there are two studies that report that for speakers with severe dysarthria, intelligibility differences between auditory and auditory–visual presentation modes are not clinically meaningful (up to 3% difference).[67,69] Also there are contextual variables that may make intelligibility of speech more difficult, such as ambient noise. This is corroborated by Wild et al. who highlights that conversations in everyday life are often made more challenging by poor listening conditions that degrade speech (e.g., electronic transmission, background noise) or by tasks that distract us from our conversational partner.[76] Another aspect to take into account is that people with PD can raise their speech performance when concentrating in short bursts when it matters, situations which may theoretically include research assessments.[87] This leads us to believe that this 50% represents a very high sentence intelligibility value for severe dysarthria. This is something to take into account because intelligibility interferes with important decisions like discharge or decision-making on alternative communication systems, especially in severe dysarthria cases.

Something that was not expected and can be observed when comparing the correct percentages of all groups for orthographic transcription of words between mild and moderate dysarthria, is that for mild dysarthria, all groups scored less. The same happened for the orthographic transcription of sentences for the general population and relatives groups, who scored higher in moderate dysarthria than in mild dysarthria. This may be influenced by the stimuli, i.e., the type of words or sentences selected for each level of dysarthria. Considering that for example, there are some errors that may not change the general meaning of the phrase or word, for more specific results a further analysis of the type of error is necessary.

In the present study we proposed to determine if SLTs have a higher inter-rater reliability in their ratings of dysarthric speech when compared with naive listeners and thos was verified, but, in general, all groups showed a high inter-rater reliability.

The audio-perceptive analysis was based on conversation samples. This choice is supported by the literature as it shows identification of perceptual features may be maximized through use of a conversational tasks.[88]

With regards to velocity, only moderate and severe dysarthria were scored with slow

velocity correspondent values. A study from Nishio and Niimi in 2001 showed that speakers with flaccid and hypokinetic dysarthria displayed near normal articulation rates compared to the rates used by speakers with other types of dysarthria.[89] One thing to note is that SLTs were much more critical of the control participant's conversation that the other levels of dysarthria. This was also noted by Dagenais et al. who reported that SLTs were more critical of the normal speakers.[83] This also make sense since SLTs have knowledge about other variables that influence the perception of speech velocity – for example, louder speech is perceived faster than softer speech; small F0 variation is perceived as faster speech than higher speaking F0.[53] There are also studies that showed that clear speech is characterized by a slower speech rate[90] which supported the lowest mean scores from SLTs.

With regards to intensity, the major reported differences were between the normal speaker and severe dysarthric speakers and this is supported by literature that states that the rigidity and bradykinesia typical of PD interfere with muscle movements including vocal cord movements that are incomplete, leading to glottal incompetence and hypophonation, which are expected to worsen with the progression of the disease.[30,36,55,58-59] Between normal, mild and moderate dysarthria there were not many differences reported. All groups scored mean values that corresponded to normal/adequate intensity, except for severe dysarthria that was associated with low intensity or volume. Interestingly, PD patients showed higher differences in mean scores between the different levels of dysarthria compared to other groups. The published literature shows that patients with PD have impaired self-perception of speech volume. This seems to be associated with abnormally high order representations of sensory events and not with auditory deficits (something that was part of our exclusion criteria).[91] In this study this did not seem to happen with the perception of speech volume of other patients making sense if that is not an association with hearing loss and PD. However, there is one study that reports that PD patients perceived interlocutor speech volumes to be louder by patients than control subjects especially at further distances.[92]

Regarding articulation, there was clearly a tendency of lower mean values as dysarthria worsens,, by all groups and despite of the differences between groups. This finding is confirmed by Skodda et al. who reported that vowel articulation in Parkinsonian speakers exhibited a significant deterioration which was not observed in the control group and therefore can be interpreted as a symptom of disease

progression.[50] Articulation seems to be a parameter that everyone can comment on more easily, even non-clinical groups. Articulation defects seem to be easier to identify by all groups, compared with other parameters such as intensity and speed and are usually mentioned more in the clinical context by relatives and patients themselves. This could be justified by the tendency of listeners to readily register when someone has speech that draws attention to itself, when pronunciation deviates from some notion of 'normal'.[62] Miller et al. mentioned that even when intelligibility is not particularly affected, altered sound production may be linked with marked psychosocial consequences for the speaker.[62]

For the last parameter, discourse comprehensibility, we also observed a tendency of lower mean values with worsening dysarthria severity, by all groups despite of the differences between groups. This parameter refers to intelligibility of speech. Its correlation to with disease severity is not well described. There is presently no consensus as to which perceptual constructs capture the impact of speech impairment secondary to dysarthria.[86] However, Weismer et al. have indicated it as been related to severity of dysarthria in research that indicated no significant difference in scaled estimates of intelligibility or severity[93] being in agreement with the results of the present study.

Because the means of the scores in the articulation and discourse comprehensibility parameters followed an expected tendency, a positive correlation between these two parameters was expected and a strong positive statistically significant correlation was observed. On the other hand, the correlation with intensity was moderate, and the correlation with speech rate or velocity was weak.

The results seems to confirm the expertise of the experts who classified the level of dysarthria of the patients selected for the study sample.

This study had certain limitations that must be highlighted. For relatives and general population groups cognitive status with the MoCA was not verified and this may be a variable to consider as with advancing age there is a greater probability of cognitive deficit and these groups had a minimum of 55 years of age. For sentence intelligibility task analysis, the type of error of the phrase and whether the type of error changed or not the meaning of the phrase was not taken into account. In 2008, Hustad described problems with the binomial scoring used in sentence transcription intelligibility tasks.[34] Specifically, words are scored as either correct or incorrect relative to the target word, a percent correct score gives equal weight to all word classes such that scores are not

transparent as to whether the listener was able to decipher the meaning or intent of the spoken message.[34] At the end, comprehension scores were consistently better than intelligibility scores for all dysarthria severity groups.[34] For future studies it will interesting to make this difference between intelligibility and comprehension, taking into account the type of errors in the orthographic transcription tasks. It made sense to correlate the results of audio-perceptive analyses of conversation with dysarthria severity, but, the N of audio-files per level of dysarthria were reduced and it is not possible to draw conclusions from this data. It will be interesting to continue this study with a higher number of participants. Another aspect that seems to deserve more attention is the correlation between articulation and intelligibility of speech by taking into account that articulation is more easily noticed and articulation defects seems to be more evident for all groups of interlocutors of PD patients.

CONCLUSIVE REMARKS

The level of speech intelligibility varies according to the listeners, and the professional groups working with dysarthria on a daily basis are more likely to understand the discourse of PD patients, even when compared with the family members that spend the most time with patients. Articulation defects are more easily perceived by any interlocutor compared to the intensity or speed of discourse, and the articulation seems to be correlated with speech intelligibility. The perception of both is more difficult as the degree of severity of dysarthria evolves, and this for all groups of interlocutors.

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Annexes

Annex I – Information sheet

Folha de Informação para os participantes a integrar o júri

Título do projeto de investigação

Análise áudio-percetiva da disartria associada à Doença de Parkinson por diferentes profissionais de saúde, doentes, familiares e população em geral.

Objetivo do estudo

O objetivo desta investigação centra-se em determinar se o mesmo discurso disártrico associado à Doença de Parkinson é entendido da mesma forma por diferentes tipos de interlocutores, com maior ou menor contacto com a doença. Principal questão de investigação: existem diferenças na inteligibilidade do discurso disártrico para diferentes interlocutores, nomeadamente: terapeutas da fala, neurologistas, familiares de doentes de Parkinson, os próprios doentes ou para a população em geral (sem contacto com a doença)?

Procedimento

Será elaborado um corpus com gravações de amostras de fala por parte de pessoas com a Doença de Parkinson e sem a doença – palavras, frases, conversa – e será reunido um júri que irá ouvir as gravações, anotar ortograficamente as palavras e as frases e realizar uma análise percetiva a um excerto de conversa, classificando cada amostra com recurso a uma escala de 0 a 5 no que diz respeito a volume, articulação, inteligibilidade do discurso e velocidade de fala.

Possíveis benefícios para os participantes

Se concordar em participar, não terá nenhum benefício clínico direto. Contudo, a sua participação poderá contribuir para o aumento do conhecimento sobre a inteligibilidade do discurso na Doença de Parkinson, o que poderá beneficiar os doentes ou terceiros no futuro. Não receberá nenhuma compensação económica pela sua participação neste estudo.

Riscos físicos previsíveis

Não está previsto qualquer risco decorrente da participação neste estudo.

Participação voluntária e direitos de abandono

Se concordar em participar, a qualquer momento pode desistir e solicitar que os dados recolhidos neste estudo sejam eliminados sem qualquer consequência para si.

Utilização dos dados

Se assinar este consentimento, dará permissão ao investigador principal envolvido neste estudo, aos seus orientadores e à equipa do JJ Ferreira Lab, Instituto de Medicina Molecular, para que utilizem informações demográficas, adequadamente anonimizadas. A informação usada neste estudo, e que poderá ser divulgada, inclui dados que serão anonimizados, de forma a que não seja possível associar a identidade às gravações ou aos dados demográficos. A futura apresentação e publicação dos resultados do estudo respeitará sempre a confidencialidade dos dados e o anonimato dos participantes.

Contatos

Poderá contactar a investigadora principal do estudo, Mestranda Joana Carvalho para responder a qualquer dúvida que tenha relativamente ao estudo e à sua participação no mesmo.

Contacto telefónico: 927854139

Email: joana.margarida.cr@gmail.com

Annex II – Informed Consent

DECLARAÇÃO DE CONSENTIMENTO INFORMADO

Título do projeto de investigação
Análise áudio-percetiva da disartria associada à Doença de Parkinson por diferentes profissionais de saúde, doentes, familiares e população em geral.

Eu expliquei detalhadamente este estudo ao participante. Como investigadora deste estudo, eu expliquei os objetivos, os procedimentos, os benefícios e os riscos que estão envolvidos neste estudo. Todas as perguntas que foram levantadas foram respondidas para garantir a compreensão do participante.

Assinatura da pessoa que obteve o consentimento	Nome da pessoa que obteve o consentimento	Data
_____	_____	_____

Eu abaixo assinado (a)....., li este formulário de consentimento e fui informado sobre o objetivo deste estudo, os procedimentos, os possíveis benefícios e riscos, e aceito participar de livre e espontânea vontade. Recebi uma cópia assinada deste consentimento. Foi-me dada a oportunidade de fazer perguntas antes de assinar, e foi-me dito que posso fazer outras perguntas a qualquer momento. Eu concordei em participar neste estudo de forma voluntária. Concordo em cooperar com a investigadora principal do estudo, Mestranda Joana Carvalho e com os seus orientadores, Prof. Doutor Joaquim Ferreira e Prof. Doutora Isabel Guimarães.
Foi-me explicado que :
Sou livre para sair do estudo a qualquer momento sem necessidade de justificar a minha decisão.
Os dados a meu respeito serão estritamente confidenciais. Posso, a qualquer momento, exercer o meu direito de acesso, retificação e oposição.
A publicação dos resultados da investigação respeitará o meu direito ao anonimato.

O meu consentimento não isenta os organizadores do estudo das suas responsabilidades. São legalmente mantidos todos os meus direitos.

Assinatura do Participante	Nome do Participante	Data
_____	_____	_____

Foi entregue um duplicado deste documento ao participante.

Annex III – CRF

Análise áudio-percetiva da disartria associada à Doença de Parkinson por diferentes profissionais de saúde, doentes, familiares e população em geral.

Investigadora principal: Joana Carvalho

CRF - *Case Report Form - Avaliador*

Projeto desenvolvido no âmbito do Mestrado em Neurociências da Faculdade de Medicina da Universidade de Lisboa

Orientador: Prof. Doutor Joaquim Ferreira
Co-Orientadora: Prof. Doutor Isabel Guimarães

Locais onde decorre o estudo:

- Laboratório de Farmacologia Clínica e Terapêutica, Faculdade de Medicina da Universidade de Lisboa (FMUL)
- CNS - Campus Neurológico Sénior, Torres Vedras

Aprovação pela Comissão de Ética Centro Hospitalar Lisboa Norte/ Faculdade de Medicina da Universidade de Lisboa, Julho 2016

Conteúdo

1. Critérios de Inclusão

População em geral

- > 55 anos Sim ❑ Não ❑
- Sem qualquer contacto regular com pessoas com doença de Parkinson, familiares ou amigos, ou qualquer conhecimento das alterações vocais associadas à doença

Sim ❑ Não ❑

Familiares de pessoas com doença de Parkinson

- > 55 anos Sim ❑ Não ❑
- 1º ou 2º grau : _____ Sim ❑ Não ❑
- Com contacto diário com a pessoa com Doença de Parkinson

Sim ❑ Não ❑

Pessoas com Doença de Parkinson

- > 55 anos Sim ❑ Não ❑
- > 3 anos de diagnóstico Sim ❑ Não ❑
- Sem declínio cognitivo com impacto na participação do presente estudo (Moca>=18) Sim ❑ Não ❑

Médicos neurologistas

- > 5 anos de experiência no seguimento de pessoas com a Doença de Parkinson

Sim ❑ Não ❑

Terapeutas da fala

- Com experiência de trabalho com adultos Sim ❑ Não ❑ especificar área de atuação :_____

- Sem experiência na avaliação ou tratamento de pessoas com a Doença de Parkinson Sim ❑ Não ❑

2. Informação para consentimento informado

O consentimento informado escrito deve ser obtido antes do início de qualquer procedimento referente ao estudo.

O consentimento informado foi obtido antes de qualquer avaliação? Sim ❑ Não ❑

O participante assinou de forma voluntária o consentimento, antes de participar. Sim ❑ Não ❑

O consentimento informado foi assinado pelo participante e investigador? Sim ❑ Não ❑

Data da obtenção do consentimento: __/__/____

Razões para não participar do estudo:_____

- Não cumpre os critérios de inclusão ❑ Especificar:

- Outras razões: _____

3. Dados demográficos

GRUPO

Familiar □

Pessoas com Doença de Parkinson □

Terapeuta da Fala □

Neurologista □

População em geral □

Data de nascimento: ____/____/_____ Idade: _____

Naturalidade: _____ Local de residência:

_____ Género: F ❑ M ❑

Para além do português fala outras línguas?

1 Inglês ☐ 2 Francês ☐ 3 Espanhol ☐ 4 Outras: _____

Escolaridade: _____

Profissão: _____

*No caso de ser neurologista, quantos anos de experiência tem com pessoas com a Doença de Parkinson? ____

**No caso de ser Terapeuta da Fala, quantos anos de experiência de trabalho com adultos? ____

Formação Musical: Sim / Não

Se sim, especificar:_____

Hábitos de leitura: Sim / Não

Se sim, com que frequência?

□ Diariamente □ Semanalmente □ Mensalmente

Contacto com pessoas com Doença de Parkinson: Sim / Não

Se sim: quantos dias por semana?_____ Quantas horas por dia? _____

Em que contexto? _____

Grau de parentesco ou relação com o doente de Parkinson _____

Conhecimento de sinais e sintomas associados à Doença de Parkinson : Sim / Não

Se sim, quais?

_____

4. Historial médico

***No caso de ser doente de Parkinson:

Data do diagnóstico: __/__/____ Data dos primeiros sintomas: __/__/____

Problemas clínicos atuais:

Flutuações motoras ☐ Discinésias ☐ Freezing da marcha ☐ Delírio/ Alucinações ☐

Sintomas vocais:

Fala arrastada □ Volume de fala diminuído □ Rouquidão □

Outros (especificar): _____

História clínica de défice auditivo diagnosticado? Sim / Não

Se sim, quando?_____

Utiliza prótese (s) auditivas? Sim / Não

Se sim, em que ouvido? OD □ OE □

Há quantos anos? _____

Estão bem ajustadas? Sim / Não

Dificuldade auditiva percecionada pelo próprio? Sim / Não

Se sim: □ OD 0-1-2-3-4-5 □ OE 0-1-2-3-4-5

Neste momento tem alguma outra condição médica (ex: constipação, alergias) que considera afetar-lhe a audição? Sim / Não

Se sim, especificar: _____

História clínica de défice cognitivo diagnosticado: atenção, memória, concentração, resolução de problemas? Sim / Não

Se sim, quando?_____

Alterações cognitivas percecionadas pelo próprio? Sim / Não

Se sim, especificar:_____

Medicação atual:

Medicação	Dosagem	Data de início

Análise áudio-percetiva da disartria associada à Doença de Parkinson por diferentes profissionais de saúde, doentes, familiares e população em geral.

Investigadora principal: Joana Carvalho

CRF - *Case Report Form - Juri*

Projeto desenvolvido no âmbito do Mestrado em Neurociências da Faculdade de Medicina da Universidade de Lisboa

Orientador: Prof. Doutor Joaquim Ferreira
Co-Orientadora: Prof. Doutora Isabel Guimarães

Locais onde decorre o estudo:

- Laboratório de Farmacologia Clínica e Terapêutica, Faculdade de Medicina da Universidade de Lisboa (FMUL)
- CNS - Campus Neurológico Sénior, Torres Vedras

Aprovação pela Comissão de Ética Centro Hospitalar Lisboa Norte/ Faculdade de Medicina da Universidade de Lisboa, Julho 2016

Grupo

Familiar ☐

Doente de Parkinson ☐

Terapeuta da Fala ☐

Neurologista ☐

População Geral ☐

A disartria representa uma alteração da fala e está presente em 70%-100% das pessoas com Doença de Parkinson e a inteligibilidade da fala, a facilidade com que um ouvinte é capaz de descodificar as declarações de um falante é um dos principais critérios utilizados para a avaliação da gravidade da disartria.

Este é um estudo que tem por objetivo perceber se a fala alterada (disartria) das pessoas com Doença de Parkinson é compreendida de forma diferente, com mais ou menos facilidade, por diferentes interlocutores. Agradeço desde já a sua participação.

1. A primeira parte consiste na anotação ortográfica de palavras.

De seguida irá ouvir uma série de palavras produzidas por pessoas com a Doença de Parkinson e sem Doença de Parkinson. Coloque os auriculares. Cada palavra será reproduzida apenas uma vez. Registe exatamente o que ouve em letras maiúsculas. Se não compreender passe à frente. Entre cada palavra terá uma pausa para escrever. Quando precisar de uma pausa maior por qualquer motivo (ex: cansaço) basta pedir à investigadora responsável.

Anotação ortográfica de palavras:

1.	26.
2.	27.
3.	28.
4.	29.
5.	30.
6.	31.
7.	32.
8.	33.
9.	34.
10.	35.
11.	36.
12.	37.
13.	38.
14.	39.
15.	40.
16.	41.
17.	42.
18.	43.
19.	44.
20.	45.
21.	46.
22.	47.
23.	48.
24.	49.
25.	50.

2. A segunda parte consiste na anotação ortográfica de frases.

De seguida irá ouvir uma série de frases produzidas por pessoas com a Doença de Parkinson e sem Doença de Parkinson. Coloque os auriculares. Cada frase será reproduzida apenas uma vez. Registe exatamente o que ouve em letras maiúsculas. Se não compreender passe à frase seguinte. Entre cada frase terá uma pausa para escrever. Quando precisar de uma pausa maior por qualquer motivo (ex: cansaço) basta pedir à investigadora responsável.

Anotação ortográfica de frases:

1.
2.
3.
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49.
50.

3. **A terceira parte consiste numa avaliação percetiva de excertos de conversa.**

Terá de classificar a fala de cada pessoa no que diz respeito a intensidade, velocidade de fala, articulação e facilidade de compreensão do discurso. De seguida ser-lhe-ão apresentados alguns conceitos e uma escala associada a cada um deles.

Velocidade de fala: ritmo que cada indivíduo utiliza no seu discurso (ex: lento, rápido).

Intensidade/ loudness (volume): A intensidade é propriedade física do sinal acústico; pode ser medida em decibéis (dB). Loudness é a sensação subjetiva de magnitude de um som que permite avaliar o nível de intensidade desse som. Por ex: 'Estás a falar muito alto'; ' fala mais baixo, não faças barulho'. Uma intensidade adequada tem variações adequadas a uma conversa.

Articulação/ Dicção: processo de produção e utilização dos sons da fala de uma determinada comunidade linguística; diz respeito à forma como a pessoa articula os sons da fala (pode ser de uma forma clara – ex: boa dicção; menos clara – má dicção). Uma articulação adequada considera-se uma articulação com precisão dos sons do Português. Uma má articulação caracteriza-se por imprecisões, trocas ou omissões de sons, tornando difícil o que está a dizer.

Facilidade de compreensão do discurso: a aptidão com que um ouvinte é capaz de descodificar as declarações de um falante (ex: fácil de compreender, difícil de compreender – não por dificuldades do ouvinte como, por exemplo, auditivas, mas pelo discurso do falante).

De seguida irá ouvir uma série de excertos de conversa. Coloque os auriculares. Cada excerto contém 20seg de conversa e será reproduzido apenas uma vez. Registe a sua perceção em relação a cada parâmetro descrito anteriormente na escala apropriada, marcando uma cruz no local que considera mais apropriado. No caso de achar uma categoria variável, como por exemplo, em parte da conversa uma velocidade de fala rápida, noutra parte lenta, assinale duas opções.

1. Nesta conversa considero

Velocidade de fala	Muito lento □	Lento □	Normal/ Adequada □	Rápido □	Muito rápido □
Intensidade	Muito baixo □	Baixo □	Normal/ Adequada □	Alto □	Muito alto □
Articulação/ Dicção	Muito má □	Má □	Normal/ Adequada □	Boa □	Muito boa □
Compreensão do discurso	Muito difícil □	Difícil □	Normal/ Adequada □	Fácil □	Muito fácil □

2. Nesta conversa considero

Velocidade de fala	Muito lento □	Lento □	Normal/ Adequada □	Rápido □	Muito rápido □
Intensidade	Muito baixo □	Baixo □	Normal/ Adequada □	Alto □	Muito alto □
Articulação/ Dicção	Muito má □	Má □	Normal/ Adequada □	Boa □	Muito boa □
Compreensão do discurso	Muito difícil □	Difícil □	Normal/ Adequada □	Fácil □	Muito fácil □

3. Nesta conversa considero

Velocidade de fala	Muito lento □	Lento □	Normal/ Adequada □	Rápido □	Muito rápido □
Intensidade	Muito baixo □	Baixo □	Normal/ Adequada □	Alto □	Muito alto □
Articulação/ Dicção	Muito má □	Má □	Normal/ Adequada □	Boa □	Muito boa □
Compreensão do discurso	Muito difícil □	Difícil □	Normal/ Adequada □	Fácil □	Muito fácil □

4. Nesta conversa considero

Velocidade de fala	Muito lento □	Lento □	Normal/ Adequada □	Rápido □	Muito rápido □
Intensidade	Muito baixo □	Baixo □	Normal/ Adequada □	Alto □	Muito alto □
Articulação/ Dicção	Muito má □	Má □	Normal/ Adequada □	Boa □	Muito boa □
Compreensão do discurso	Muito difícil □	Difícil □	Normal/ Adequada □	Fácil □	Muito fácil □

5. Nesta conversa considero

Velocidade de fala	Muito lento □	Lento □	Normal/ Adequada □	Rápido □	Muito rápido □
Intensidade	Muito baixo □	Baixo □	Normal/ Adequada □	Alto □	Muito alto □
Articulação/ Dicção	Muito má □	Má □	Normal/ Adequada □	Boa □	Muito boa □
Compreensão do discurso	Muito difícil □	Difícil □	Normal/ Adequada □	Fácil □	Muito fácil □

6. Nesta conversa considero

Velocidade de fala	Muito lento □	Lento □	Normal/ Adequada □	Rápido □	Muito rápido □
Intensidade	Muito baixo □	Baixo □	Normal/ Adequada □	Alto □	Muito alto □
Articulação/ Dicção	Muito má □	Má □	Normal/ Adequada □	Boa □	Muito boa □
Compreensão do discurso	Muito difícil □	Difícil □	Normal/ Adequada □	Fácil □	Muito fácil □

7. Nesta conversa considero

Velocidade de fala	Muito lento □	Lento □	Normal/ Adequada □	Rápido □	Muito rápido □
Intensidade	Muito baixo □	Baixo □	Normal/ Adequada □	Alto □	Muito alto □
Articulação/ Dicção	Muito má □	Má □	Normal/ Adequada □	Boa □	Muito boa □
Compreensão do discurso	Muito difícil □	Difícil □	Normal/ Adequada □	Fácil □	Muito fácil □

8. Nesta conversa considero

Velocidade de fala	Muito lento □	Lento □	Normal/ Adequada □	Rápido □	Muito rápido □
Intensidade	Muito baixo □	Baixo □	Normal/ Adequada □	Alto □	Muito alto □
Articulação/ Dicção	Muito má □	Má □	Normal/ Adequada □	Boa □	Muito boa □
Compreensão do discurso	Muito difícil □	Difícil □	Normal/ Adequada □	Fácil □	Muito fácil □

9. Nesta conversa considero

Velocidade de fala	Muito lento □	Lento □	Normal/ Adequada □	Rápido □	Muito rápido □
Intensidade	Muito baixo □	Baixo □	Normal/ Adequada □	Alto □	Muito alto □
Articulação/ Dicção	Muito má □	Má □	Normal/ Adequada □	Boa □	Muito boa □
Compreensão do discurso	Muito difícil □	Difícil □	Normal/ Adequada □	Fácil □	Muito fácil □

10. Nesta conversa considero

Velocidade de fala	Muito lento □	Lento □	Normal/ Adequada □	Rápido □	Muito rápido □
Intensidade	Muito baixo □	Baixo □	Normal/ Adequada □	Alto □	Muito alto □
Articulação/ Dicção	Muito má □	Má □	Normal/ Adequada □	Boa □	Muito boa □
Compreensão do discurso	Muito difícil □	Difícil □	Normal/ Adequada □	Fácil □	Muito fácil □